PATENT SPECIFICATION 954,592

DRAWINGS ATTACHED.

954,592

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International Classification :—**E 05 f** (E 05 c, F 06 h).

COMPLETE SPECIFICATION.

Apparatus for Opening and Closing the Door of a Vehicle.

I, KUNIMORI MARIYAMA, a Citizen of Japan, residing at 42 Asahi-machi 2 chome Kawasaki, Kanagawa Prefecture, Japan, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement : —

This invention relates to an electrical apparatus for the opening and closing of the door of a vehicle, under the control of an electric motor operated by a switch or switches placed within the driver's reach.

The main object of the invention is to prevent the hurting of persons standing by the door, and the shocking and eventually shaking out of the passengers by a sudden and unexpected opening of the door.

A further more specific object of the invention is to enable the door to be opened and closed freely also by hand, by operating the door handle normally whilst the electric motor is cut off from the electric source by the opening of a switch. Thus the opening and closing system of the door is protected against breaking by force.

A still further object of the invention is to make it possible to install the arrangement at low cost and without harming the appearance, since the arrangement is simple and can easily be set within the door itself as the structure is not voluminous and it is enough to connect the equipment with the instrument panel by means of wires.

The invention provides electric opening and closing means for a vehicle door which is furnished with a latch member normally held in the latching position, comprising an electric driving motor, an epi-cyclic gearing driven by said motor and a solenoid-operated latch control, wherein actuation of a control switch to a "door-open" position both energises the motor to rotate the epi-cyclic gearing and also operates the solenoid to place an obstruction in the path of rotation of one element of said gearing, the meeting of said element with said obstruction and the consequent limited displacement of said obstruction withdrawing the said latch from the normal latching position and the arresting of the movement of the obstruction and the element by means of a stop then causing the rotation of another part of said epi-cyclic gearing to drive means for imparting successive stages of opening movement to the door, the subsequent switching off of said driving motor and solenoid allowing the latch to resume its normal position.

Usually the arrangement will be characterised in that the annulus of said epi-cyclic gearing is arrested by the said obstruction, and the planet cage of the gearing is the member whose rotation imparts opening movement to the door, said cage carrying a pin which in successive rotations of the cage enters successive notches in a sliding bar to impart thrust to that bar for opening the door. The device may be built into a hollow door and have the said sliding bar pivotally attached at one end to a fixed part of the vehicle body.

The invention will be described in the following with reference to the accompanying drawings wherein : —

Fig. 1 shows a general layout of an arrangement when the door is closed. The motor as well as a reduction gear therefor are not shown;

Fig. 2 is the plan of the arrangement shown in Fig. 1 and including a control switch and wirings;

Fig. 3 is a part-sectional front view of the epi-cyclic gearing;

Fig. 4 is a cross section on the line 4—4 of Fig. 3;

Fig. 5 shows a front view of the arrangement when in a condition such that the control switch is closed to open the door, and the electromagnet is being energised;

Fig. 6 is a view similar to Fig. 5 but showing the condition when the process of opening the door is completed;

Fig. 7 is a front view of a modified arrangement for carrying out the invention, partly in section;

Fig. 8 is a plan of the arrangement shown in Fig. 7;

Figs. 9 and 10 are longitudinal sectional views along the lines 9—9 and 10—10 respectively of Fig. 8;

Fig. 11 shows a cross sectional view on the line II—II of Fig. 7; and

Fig. 12 shows a view corresponding to Fig. 10 but at the moment when the switch is closed to open the door.

Referring first to the embodiment shown in Fig. 1 to 6, the device is built as follows:

An electric motor 22 and a case containing a reduction gear 23 are mounted within the interior part of the hollow door 20 and a rubber covered friction driving sun wheel 25 is mounted on the slow driving shaft 24 whilst three planet pinions 26 rotating as friction transmission gears are fixed upon the side frame 27. Another frame 28 with a rough inner circular surface 29 operating as an annulus is loosely fixed on the said side frame 27. The pinions 26 touch this surface 29. When the driving shaft 24 is rotated either one or other of the frames 27 and 28 may rotate in an opposite direction, these parts comprising an epi-cyclic gear 30.

The epi-cyclic gear 30 is fixed on the frame 21 of the door through the driving shaft 24. A claw 34 is installed on the outer frame 28 of the gear 30, and this co-operates with a swinging lever 33, to which is connected the core of a Bowden cable adapted to draw back the latch (not shown) for locking and unlocking the door. At the same time another claw 36, mounted on the frame 27 interlocks with the push bar 35 to push and pull the side frame 27 of the gear through an arc of rotation.

The said swinging lever 33 is U-shaped and is mounted on the frame 21 by means of the pivot 38 so that the lever may move freely around such pivot. At one end of the swinging lever 33 the cable 32 is fastened, and at the other end there is a sliding member 40 the rear end of which is connected by a pivot joint to the upper part of a lever 39 mounted on the lever 33 by means of the pivot 38. The stop member 40 is actuated by the upper end part of the lever 39 and can move to and fro through the bush 41 in the swinging lever 33. At the lower end of the lever 39, a long narrow slot is made, into which the narrow end of the iron core 44 of the electromagnet 43 is inserted loosely, to allow of some free movement. When the magnet 43 is energised, the iron core 44 is drawn in, as shown in Fig. 5 and, by means of the lever 39 pushes the stop member 40 forwards until its point comes into the path of the claw 34 on the outer frame 28. Upon the rotation of the outer frame 28, the said point hits the claw 34 and the swinging lever 33 then rotates until the lever 40, together with the swinging lever is arrested by either one of the stops 53 or 54 which are set on the frame 21 of the door, respectively a little above and below the member 40. When the magnet 43 is de-energised, the iron core 44 withdraws from the coil and the stop member 40 is thereby returned to its normal position and its end is again out of the path of the claw 34.

The push bar 35 is so held on the frame 21 that it can move back and forth, and its extension—the connecting rod 47—is connected at the extremity to the fixed support 46 of the vehicle body, to which the door 20 is attached through a hinge joint 45. The extension 47 of the bar is pivotally connected to the bifurcated metal piece 48, which is fixed to the support 46. There is thus an articulated connection between the fixed part 46 and the bar 35, and the opening and closing movements of the door are brought about by sliding of the bar through its supports on the door.

The push bar 35 is provided with three notches 49, 50, 51 in its lower edge. When the side frame 27 with the claw 36 on it rotates such claw moves into the said notches one after another and, at every rotation it moves the bar 35 to the right or left by the distance between two adjacent notches. The door is opened or closed completely at the third rotation making two short stops during the process.

On a switch in the driver's compartment are setting positions namely O for opening the door, N for neutral and S for closing the door. The circuitry is so arranged that the motor 22 and the magnet 43 are cut off from the electric source 55 at the neutral position whereas at the opening and closing positions the motor is connected to the source 55 in the one and the other directions respectively and the magnet 43 is connected in the same direction at the same time.

Assuming the arrangement to be in a door-closed condition as shown in Fig. 1, when the switch is closed at O to open the door the motor 22 and magnet 43 are supplied with current. The driving shaft 24 is thus rotated in the direction marked with an arrow, that is to say clockwise, and the magnet 43 pulls in the iron core 44 and thereby draws the operating lever 39 and

pushes the stop member 40 forward with its end in the path of the claw 34.

As the driving shaft 24 rotates, both the side frame 27 and the outer frame 28 try to rotate clockwise but the claw 36 on the side frame 27 meeting the edge of the notch 51 of the push bar 35, and the said bar being arrested because of the locked door, the side frame 27 stops turning, as also does the swinging lever 33 if it has now been caught up by the claw 34, and only the outer frame 28 rotates, but now in a counter-clockwise direction until the claw 34 hits the end of the stop member 40 from above. When the member 40 meets the stop 54 on the frame 21, the cable 32 has been pulled (Fig. 6) and the notch that has until then kept the door locked is released.

As soon as the rotation of the outer frame 28 stops, the side frame 27 begins to turn in an opposite direction, that is to say, clockwise, and the claw 36 moves into the notches 51, 50, 49 on the push bar 35 one after another, and shifts that bar to the right by about three times the distance between two adjacent notches and opens the door completely.

Then, when the control switch is set back to the neutral position N, and thus the motor and the electro-magnet are cut off from the electric source 55, the iron core 44 withdraws out of the coil and the stop member 40 is released from the claw 34 and returns to the original position, and therefore the cable 32 becomes slack and allows the latch to move into the door-locked condition as soon as the door is closed.

When the control switch 52 is shifted to the position S for closing the door, the magnet 43 is again connected to the electric source 55 as described above, and the motor 22 is set to rotate in the reverse direction, and the end of the stop member 40 is moved into the path of the claw 34, as the driving shaft 24 begins to turn in the reverse direction, i.e. counter clockwise and tries to turn the side frame 27 and the outer frame 28 counter clockwise.

But, the claw 36 meeting the edge of the notch 49 on the push bar 35, causes the outer frame 28 to turn clockwise, and this pushes the claw 34 against the lower side of the advanced stop member 40 and moves it and the swinging lever 33 until that lever hits the stop 53 or the frame 27. The rotation of the outer frame 28 thus stops. In consequence, side frame 27 turns in an opposite direction, i.e. counter clockwise, and its claw 36 moves into the notches 49, 50, 51 one after another and, after the third rotation the push bar 35 has moved back and the door is closed. By putting the switch 52 to the neutral position N, the motor 22 is stopped and, at the same time, the magnet 43 is de-energised and the stop member 40 returns to the idle position. The latch (not shown) becomes locked as soon as the door is closed because the cable 32 connected to the swinging lever 33 has become slack.

In the embodiment shown in Figs. 7 to 12, instead of friction pinions in the epi-cyclic gear 30, normal gears are employed and, in place of unlocking the door latch by pulling the cable 32 and rotating the swinging lever 33 by pushing the stop member 40 with the claw 34 on the outer frame 28, the mechanism is operated by entraining and rotating to a certain extent, the hook lever 60 which is connected to the cable 32, energisation of the magnet 43 causing engagement of the hook with one of a series of notches 61 made on the outer periphery of the outer frame 28. This moves the hook and pulls the cable 32, and the push bar 35 is shifted, while the claw 36 of the side plate 27 rotates over a wide angle, because of the extended edges of the centre notch 63 of the notches 62, 63, 64 in the push bar, and it is so arranged that the door 20 stops twice during the opening and closing operations. The shifting distance governed by the notch 63 is longer than that governed by the other two notches.

In this application, the motor 22, a worm 67 and a worm wheel 68 for transmitting the drive from the motor through a flexible shaft 66 are installed on a second frame 65 also mounted inside the hollow door 20. Three small planet pinions 71 intermesh with the small sun wheel 70 on the axis of the said worm-wheel and are held between the side frame 27 and the outer frame 28, which latter covers the side frame loosely and is provided with teeth on its inner surface, into which the pinions 71 mesh. The frame 28 is also provided with a number of notches 61. These parts constitute a planetary transmission gear 30, which is enclosed within a circular outer frame 73.

The end part of the hook lever 60 is made of a flexible plate 74 terminating in a hook part 75 which fits into the opening 80 of the outer frame 73. The hook lever 60 is provided with a lug having a slot 76 and a pin 77 protruding from the said second frame 65 extends into this slot so that the lever can move back and forth freely.

A spring 79 is fixed at one end to the supporting piece 78 fastened to the frame 65 and forming an abutment for the sheath of the Bowden cable, and at the other end to the tail part of the hook 60, which spring keeps the entire mechanism stressed towards the idle position. At the same time the magnet 43 is installed below the tail side of the hook 60, and its iron core 44 contacts the lower surface of the hook plate. When the magnet is cut off from the electric source, the hook part 75 goes a little upward from

the outer frame 28 into the opening or upper space 80 of the circular frame 73, and when the magnet 43 is energised, the iron core 44 moves outwardly and pushes up the tail part of the hook, to the left of the pin 77 in the drawing, and therefore, the hook part 75 comes down towards the outer frame 28 and fits into one of the notches 61 when the outer frame is rotated clockwise in the drawings. The hook 75 and the adjoining flexible elastic plate are thereby moved out of the upper space 80 and into the notch 81 made on the circular frame 73, and the hook pulls the cable 32 which is attached to the tail part of the hook 60. This unlocks the latch (not shown) which until then had locked the door 20 and, at the same time, the pin 77 in the slot 76 is arrested at the back end of the slot. Further rotation of the outer frame 28 is thus prevented and the side frame 27 begins to rotate in an opposite direction.

When the door is to be closed the electromagnet 43 is energised, the motor 22 is energised and the outer frame 28 begins to rotate in a counter clockwise direction, and the hook lever 60 returns to the starting point. The hook 75 is pressed against the outer frame 28 and gets into a notch 61 and the frame 28 stops turning, causing the side frame 27 to turn in an opposite direction, that is to say, clockwise.

The device may be arranged as follows:

The push bar 35 may be installed parallel to the side frame 27 of the planetary gear 30 and close to it and supported by the frame 65 with free movement to and fro along the frame. Three notches 62, 63, 64 are made on the push bar or plate 35, into which notches the claw 36 of the side frame 27 moves, over a certain angle of rotation. The two sides of the centre notch 63 are extended upward, thus forming a deeper notch than the other two 62, 64 and making the distance of the shifting of the push bar 35 performed by the claw 36 in the central notch 63 longer than when in the notches 62, 64.

A foot 82 extending down from the push bar or plate 35 (in Fig. 9, 10 and 12) supports a shock-absorbing member 83 which can move parallel to the lower edge of the push bar 35. The member 83 is provided with opposed springs 84, 85 between its ends and the part 82.

The shock-absorbing member 83 is further extended to reach the fixed part 46 of the vehicle body through a joint 87, a lever 86 and a joint 48 with bifurcated bracket and pivot pin 88. The switch 52 (Fig. 7) that connects the motor 22 and the magnet 43 to the current source is installed somewhere in the driver's compartment, as in the first-described example and, when the switch is set at the neutral position N, the motor and magnet are cut off from the electric source 55. When the switch is set to the door-opening position O, or door-closing position S, the motor and the magnet are connected to the source 55, the motor being driven positive or negative as the case may be.

The switch may be a multi-pole switch having opening, closing and neutral sets of contacts. It may also be operated by a push button for opening and closing the circuit so that the circuit is cut by means of a spring when the button is released.

The above-mentioned arrangement will be explained in more detail in the following referring to the drawings:—

The opening of the door from the closed state is performed at first by operating the control switch 52 to supply the motor 22 and magnet 43 with electric current. This rotates the shaft 69 of the planetary gear 30 counter clockwise and at the same time energises the magnet 43 to push out the iron core 44 and press the hook 75 of the hook lever 60 against the outer frame 28 of the gear so that the hook enters into a notch 61. The side frame 27 then turns counter clockwise and its claw 36 meets the edge of the notch 64 of the push bar 35 and tries to shift it, to the right in the drawing, i.e. tries to push it for opening the door. But as the door is locked, the connecting lever 86 and the shock-absorbing member 83 are held against movement and the frame 27 stops, the outer frame 28 then rotating in the clockwise direction. Therefore the hook 75 and its lever 60 are pulled as shown in Fig. and the hook 75 and its adjoining flexible plate are drawn in to the notch 81 of the frame 73, between that frame and the outer frame 28, until the hook lever 60 is arrested by the pin 77 meeting the back end of the oblong slot 76. The cable 32 is pulled during this movement and the latch (not shown) that kept the door locked being new released, the door begins to open by the extending force of the spring 85 mentioned above, and at the same time, the side frame 27 begins to turn counter clockwise as a result of the halting of the outer frame and while the claw 36 stays in the notch 64 of the push bar 35, the rod 83 shifts to the right and opens the door. The claw 36 eventually gets out of the notch 64 and the process of opening the door comes temporarily to an end.

The push bar 35 is now pushed to the right again until the claw 36 is released after meshing into the notch 63 during the second turn of the side frame. The distance of shifting is in this case bigger than in those of the other two notches, as the above mentioned notch 63 is deeper and, at the third rotation of the side frame, the push bar travels to the right by the same distance as at the notch 64, while the claw 36 stays in

the notch 62 and the door is now completely open.

When the control switch 52 is set at the neutral position N the motor is stopped, the magnet is de-energised, the iron core 44 withdraws into the coil and the spring 79 pulls the hook lever 60 so that the hook after turning the outer frame 28 is released from the notch 61 into the space 80 of the circular frame 73, while the tail part from the pin 77 of the hook 60 (left part in the drawing) comes down, thus raising the hook 75 a little and the parts are now in the neutral state.

Setting the control switch 52 to the door closing position S, connects the motor to the electric source, reversing the positive and negative of the above case, and to the electro-magnet, as well as in the above case, shifting the hook lever 60 to a small extent to allow the hook 75 to enter into the notch 61 of the outer frame. In consequence, the side frame rotates in an opposite direction to that in the above example, that is to say, clockwise, the claw 36 is entered into the notches 64, 63, 62, one after another, and the push bar 35 is shifted to the left intermittently. The spring 84 of the shock-absorbing rod 83 becomes compressed and the bar is shifted in the direction to close the door. Also, in this case the travelling distance is longer at the time when the claw 36 works in the notch 63 than when it works in the other notches 62, 64. The angles of closing of the door are proportional to the said distances and the door is closed completely after the three intermittent intervals.

The control switch is then returned to the neutral position, after the door is thus closed, and then the motor stops, the magnet is de-energised and the hook part 75 of the hook lever 60 is released from the notch of the outer frame. The cable 32 being then slack and the latch ready for locking, the door is locked as soon as it closes.

The invention provides that the door can be opened and closed not only automatically, but also freely by hand when the switch is set at the neutral position. At this time, the outer frame 28 of the planetary gear 30 being set free from the side frame 27 the latter is in a position to move freely in either direction. Therefore, the claw 36 of the side frame 27 moves out the notch 64 of the push bar 35, when the door is to be opened from its closed state, as shown in the drawing, and then the claw rises up along the arc formed by the edge of the notch 63 and descends along the notch 62 and the door is opened completely.

When the door is to be closed by hand, after the door has been opened electrically and the claw 36 is situated at the mouth of the notch 62, the said claw passes over the push bar and the door can be closed. In all those cases, the process of opening and closing the door is performed in three stages because of the three notches on the push bar, but the number of notches may be two or four, if desired, to make corresponding stages in the opening and closing movement.

This invention is not limited to the constructional embodiments described above. It may be incorporated also in other constructional forms within the scope of the appended claims.

WHAT I CLAIM IS:—

1. Electric opening and closing means for a vehicle door which is furnished with a latch member normally held in the latching position, comprising an electric driving motor, an epi-cyclic gearing driven by said motor and a solenoid-operated latch control, wherein actuation of a control switch to a "door-open" position both energises the motor to rotate the epi-cyclic gearing and also operates the solenoid to place an obstruction in the path of rotation of one element of said gearing, the meeting of said element with said obstruction and the consequent limited displacement of said obstruction withdrawing the said latch from the normal latching position and the arresting of the movement of the obstruction and the element by means of a stop then causing the rotation in the opposite direction of another part of said epi-cyclic gearing to drive means for imparting successive stages of opening movement to the door, the subsequent switching off of said driving motor and solenoid allowing the latch to resume its normal position.

2. Means according to Claim 1, wherein the annulus of said epi-cyclic gearing is arrested by the said obstruction, and the planet cage of the gearing is the member whose rotation imparts opening movement to the door, said cage carrying a pin which in successive rotations of the cage enters successive notches in a sliding bar to impart thrust to that bar for opening the door.

3. Means according to Claim 2, built into a hollow door and having said sliding bar pivotally attached at one end to a fixed part of the vehicle body.

4. Means according to Claim 2 or 3, wherein said motor is reversible and wherein movement of the control switch to a "door-close" position energises the solenoid to advance said obstruction and reverses the direction of the driving motor, and wherein the consequent rotation of the cage of the epi-cyclic gearing is obstructed by said sliding bar, causing the annulus to rotate in a direction to engage said obstruction, the eventual arresting of the annulus reversing the rotation of the cage so that on successive rotations its pin engages the successive slots

in the sliding bar to impart closing thrust to the door.

5. Means according to Claim 1 constructed and adapted to operate substantially as the embodiment herein described with reference to and as illustrated in Figs. 1—6 of the accompanying drawings.

6. Means according to Claim 1 constructed and adapted to operate substantially as the embodiment herein described with reference to and as illustrated in Figs. 7—12 of the accompanying drawings.

Agents for the Applicant,
SYDNEY E. M'CAW & CO.,
Chartered Patent Agents,
17 St. Ann's Passage,
Manchester 2.

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Fig.1.

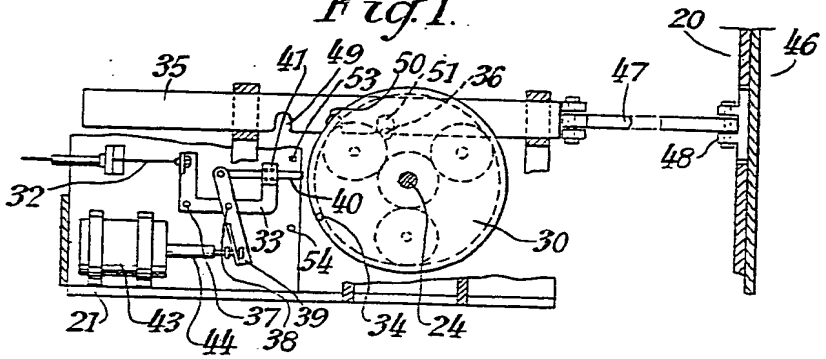
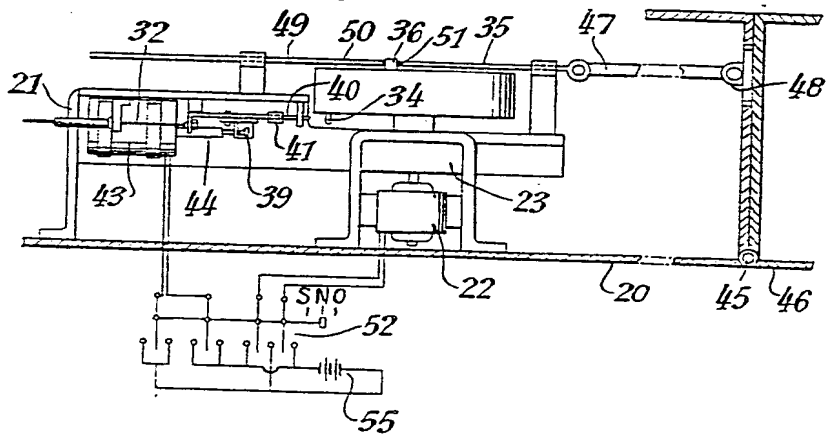


Fig.2.



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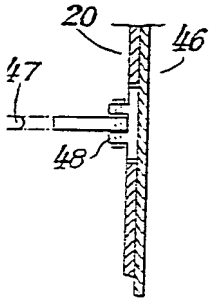


Fig.3.

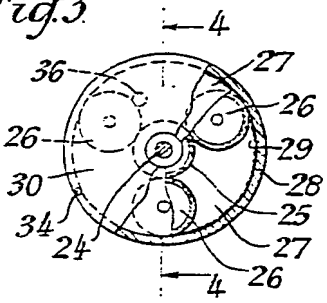
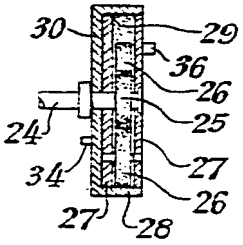


Fig.4.



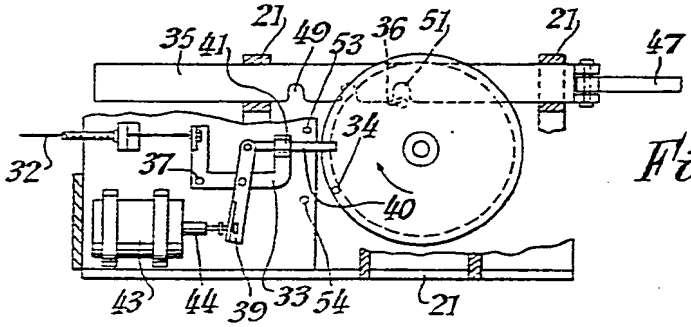
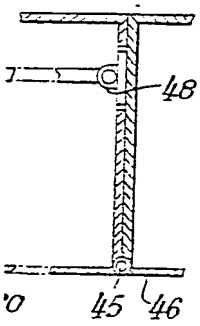


Fig.5.



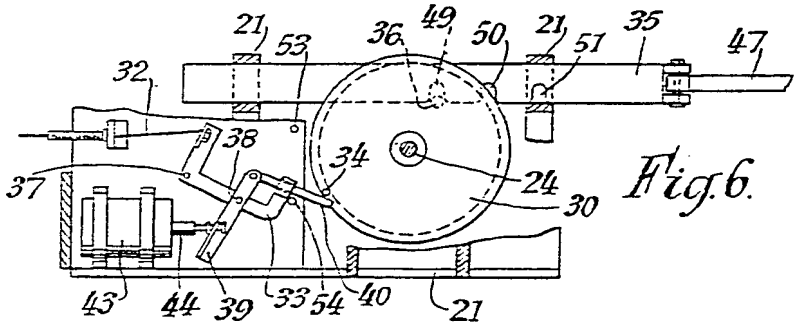


Fig.6.

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Fig.1.

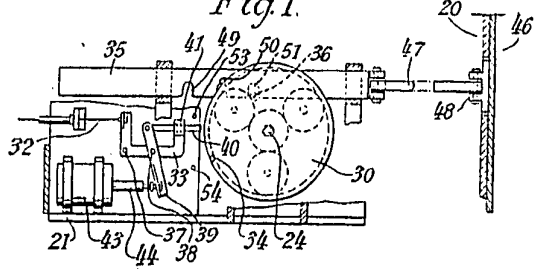


Fig.2.

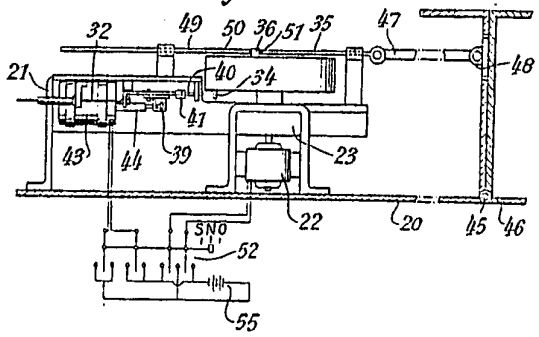


Fig.3.

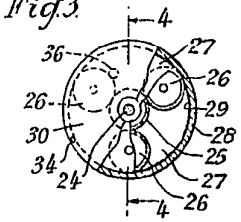
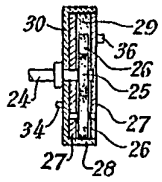


Fig.4.



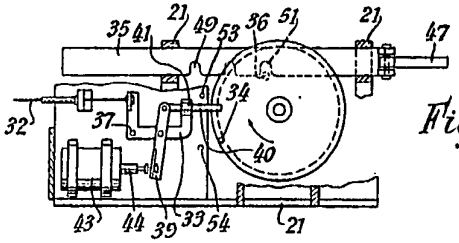


Fig.5.

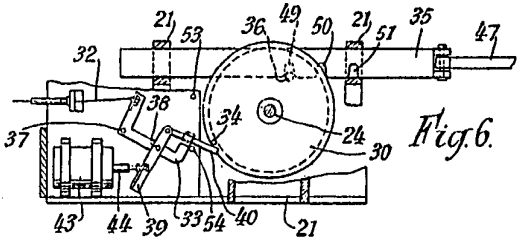
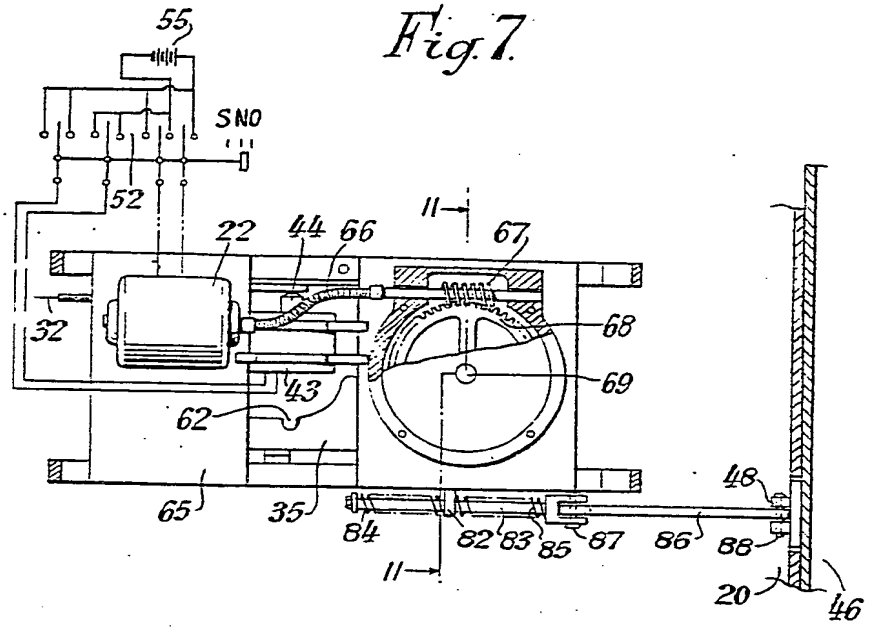


Fig.6.

Fig. 7.



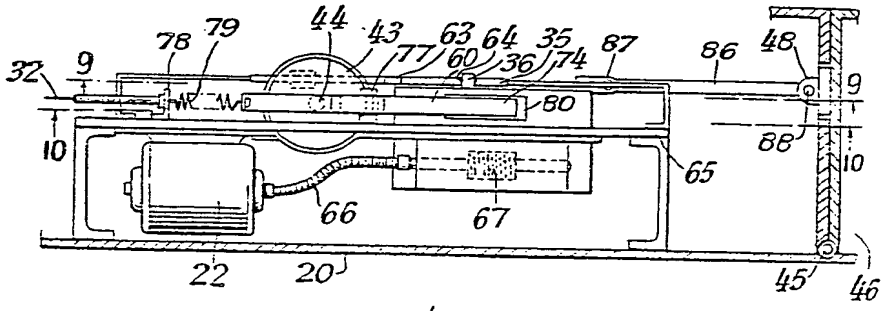


Fig. 8.

954592 COMPLETE SPECIFICATION

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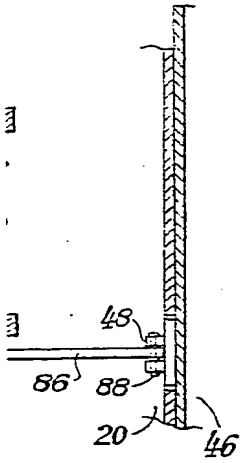
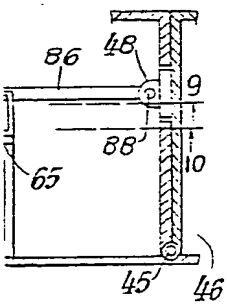
Sheets 3 & 4





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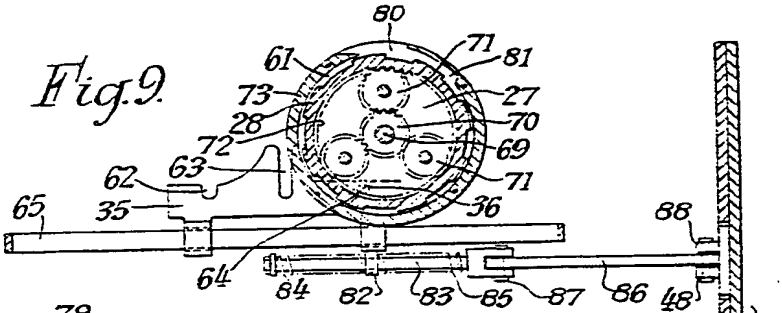


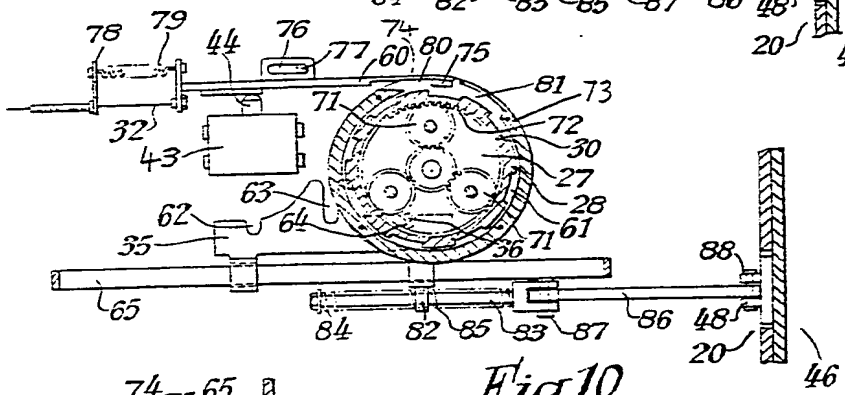


Fig.10.

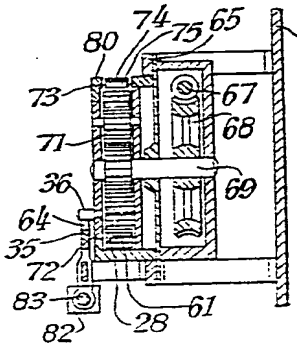


Fig.11.

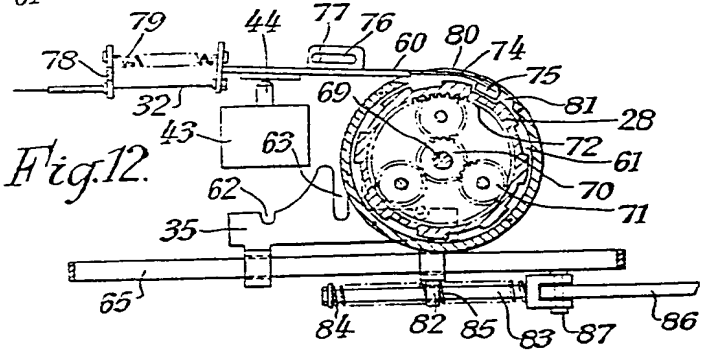
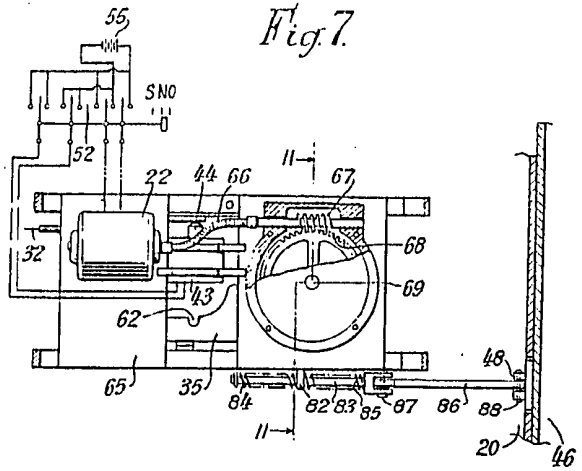


Fig.12.

954592 COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 3 & 4

Fig.7.



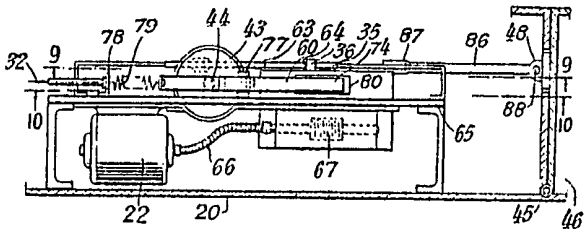
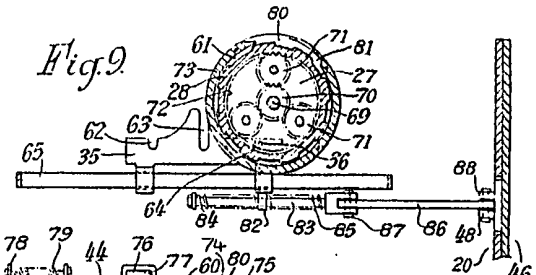


Fig.8.

Fig.9.



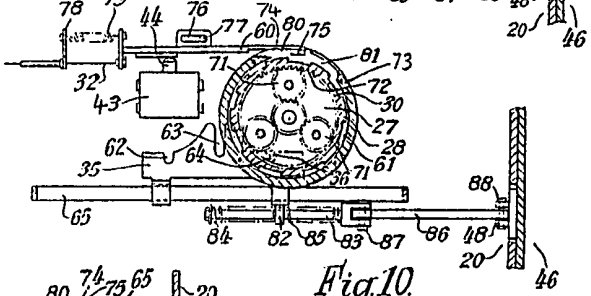


Fig.10.

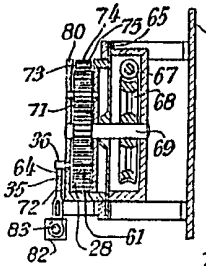


Fig.11.

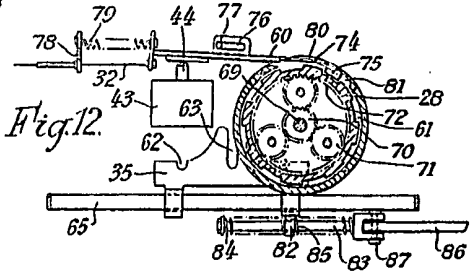


Fig.12.

Fig. 1.

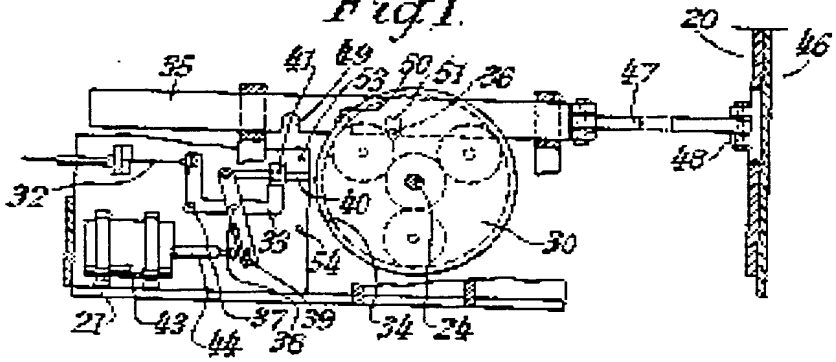
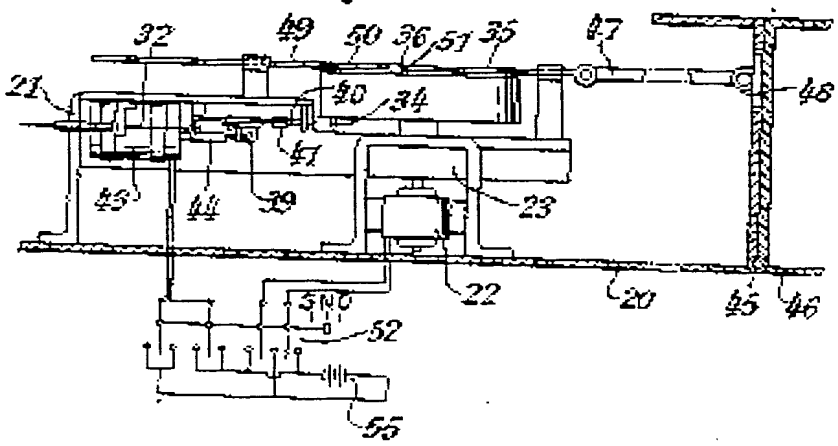


Fig. 2.



954592 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 1 & 2

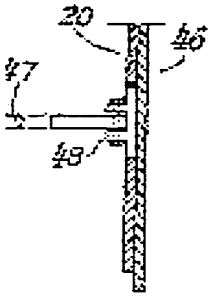


Fig.3.

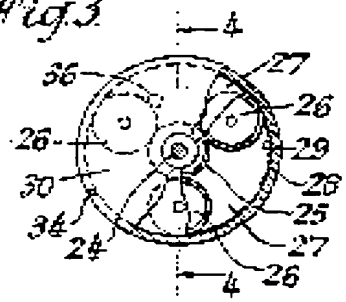
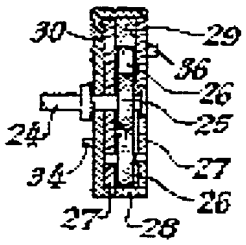


Fig.4.



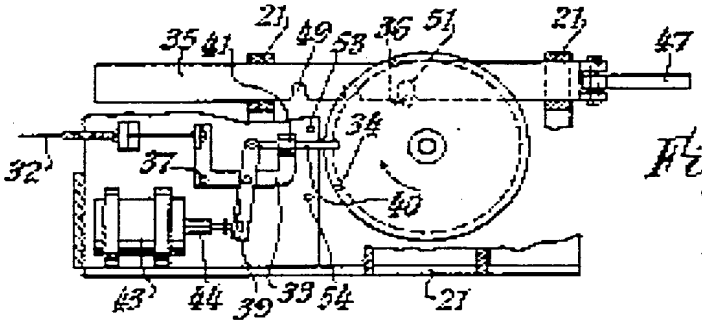
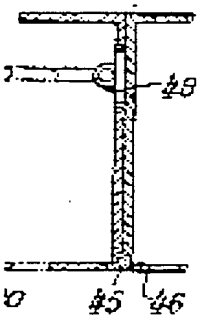


Fig.5.



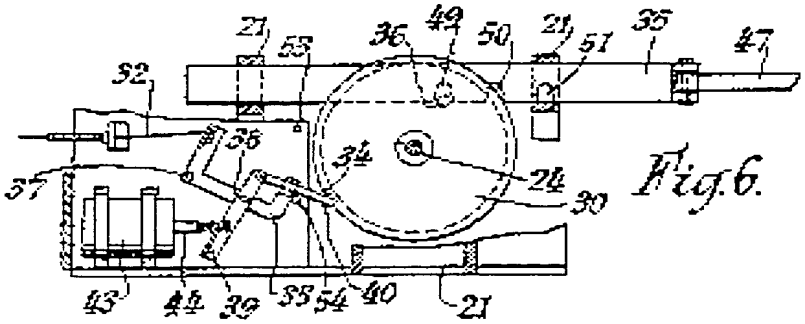


Fig.6.

954592 COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 1 & 2

Fig.1.

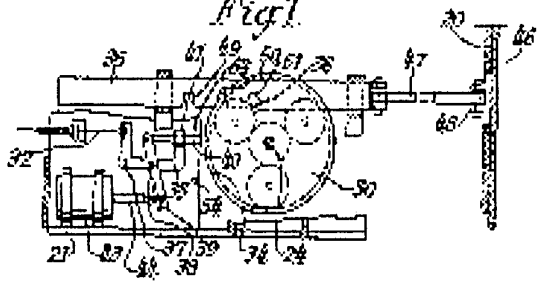


Fig.2.

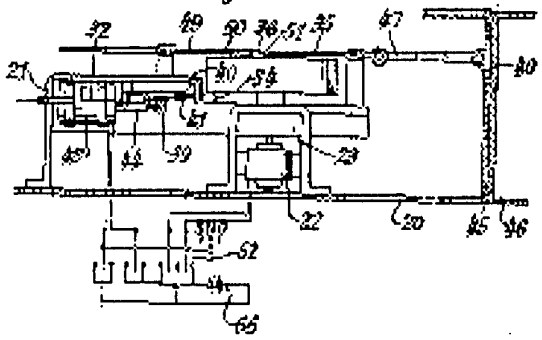


Fig.3.

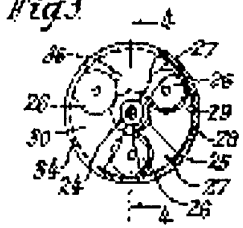
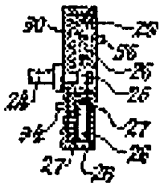


Fig.4.



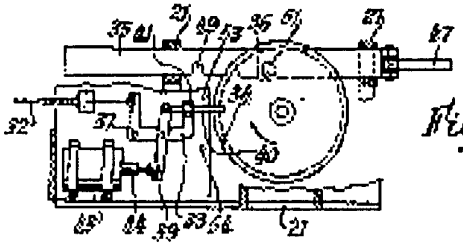


Fig.5.

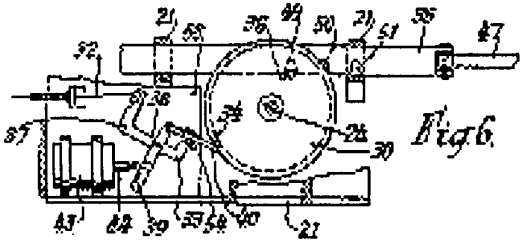
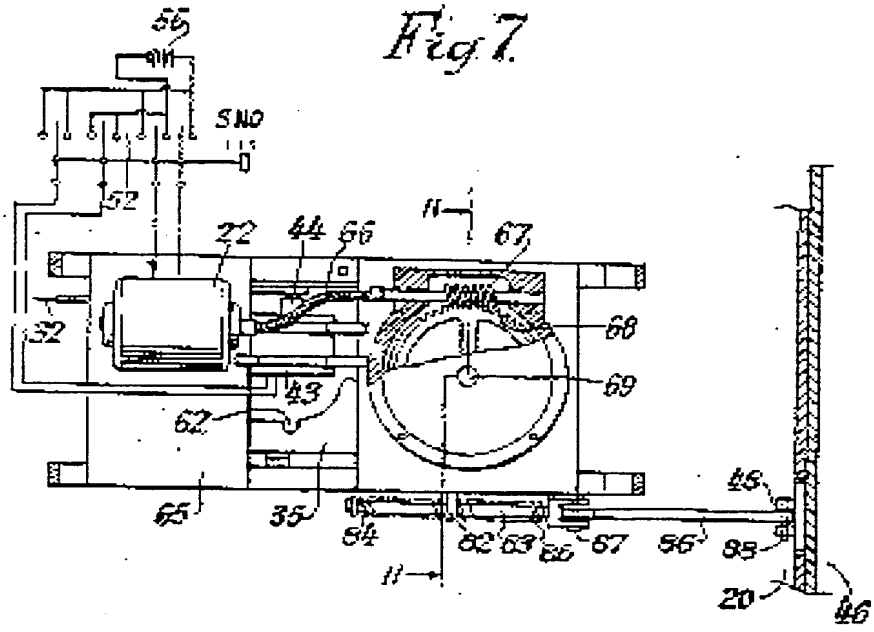


Fig.6.

Fig. 7.



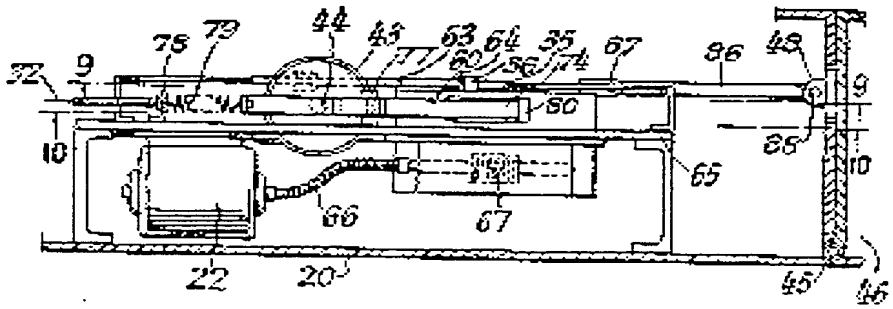


Fig. 8.

954592 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 3 & 4

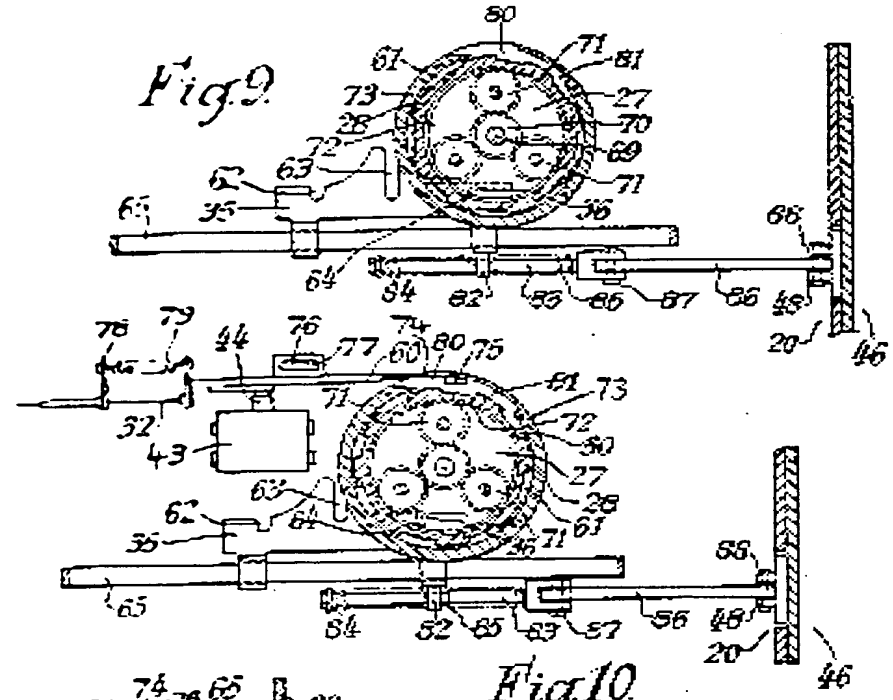
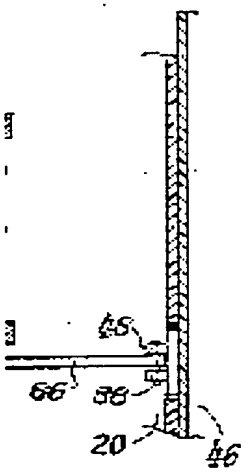


Fig.9



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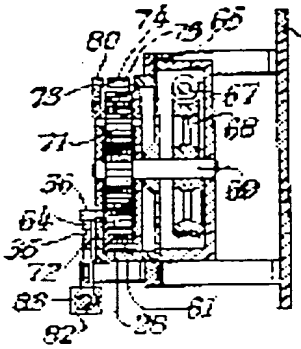
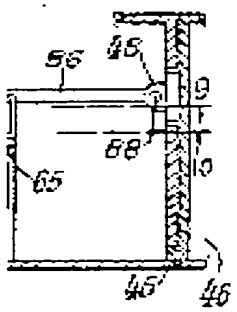


Fig.11



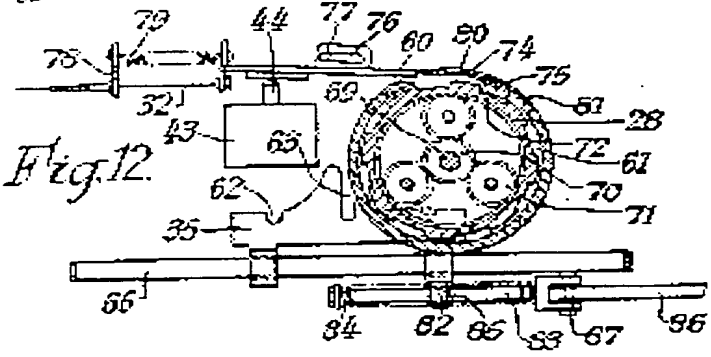


Fig.12

954592 COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 3 & 4

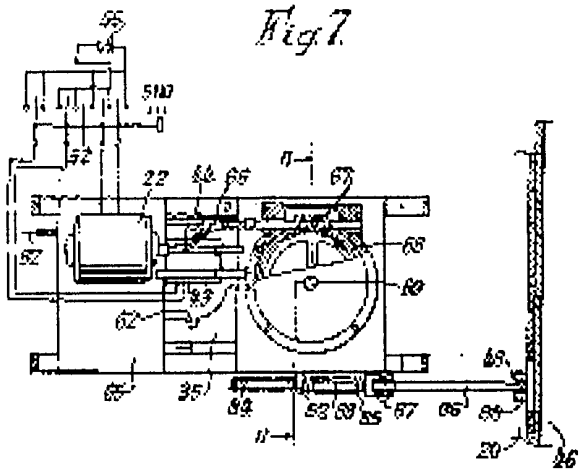


Fig.7

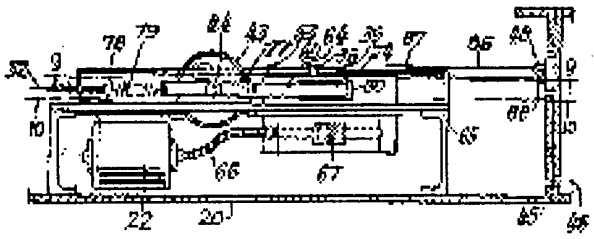


Fig.8

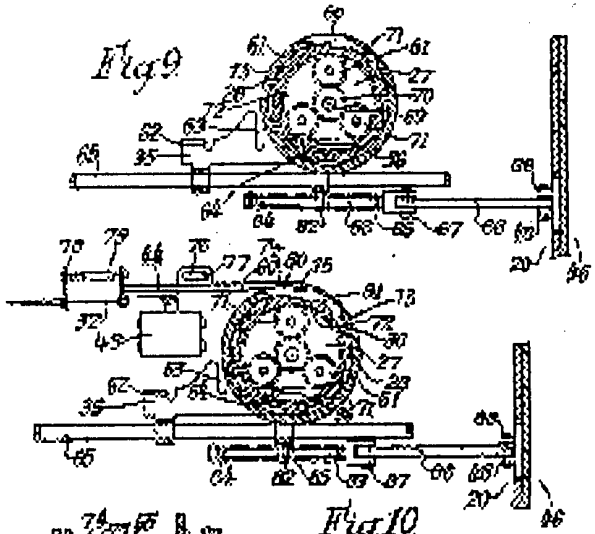


Fig.9

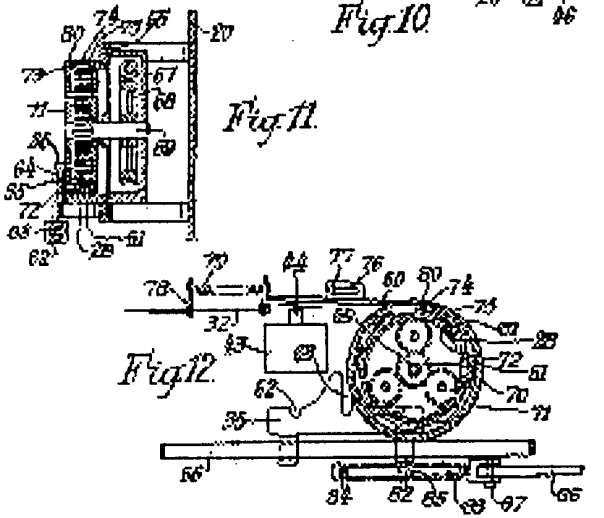


Fig.10

Fig.11

Fig.12